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THE ENVIRONMENT OF THE APE MAN

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AT that late epoch of the earth's history which immediately preceded the development of continental ice sheets, or the Pleistocene Glacial period in North America and Europe, we find but little evidence of what the next few thousand of years had in store for the rich terrestrial faunas and floras that had spread from Gibraltar to Korea and probably across the Bering land bridge between Asia and America, and over a part of the latter continent.

The Pliocene age, as the era immediately preceding the Glacial period is termed, probably witnessed the most profuse and diversified mammalian life and arborescent flora that the world has ever seen. The fauna, sometimes known as the Hipparion fauna, from the abundance at that time of the small fleet horses of the Hipparion type, is somewhat better known than the flora for the whole eurasian area, although for the area of Europe the flora is very well represented at a large number of localities. The fauna as shown by the accompanying sketch map (Fig. 1) has been traced from the Tagus Valley on the west to Korea

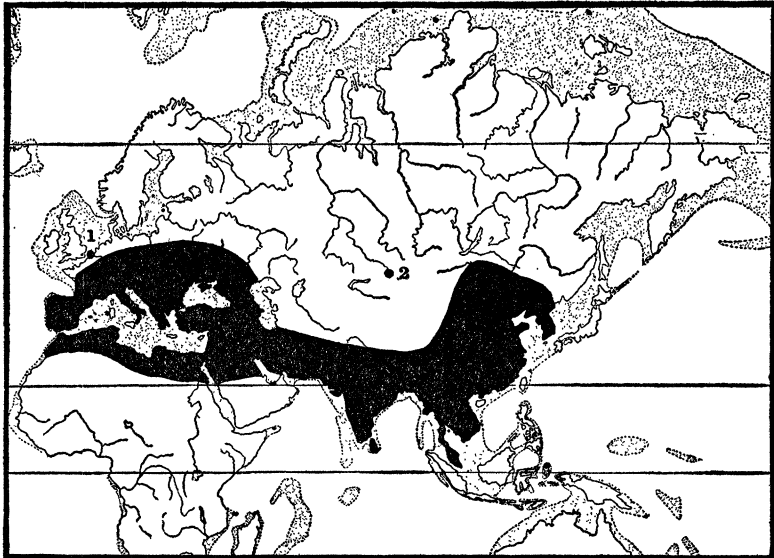


FIG. 1. SKETCH MAP SHOWING RANGE OF THE PLIOCENE HIPPARION FAUNA AND GREATER EXTENSION OF THE FLORA. 1, Pliocene flora of Holland-Prussian border. 2, Pliocene flora of Altai region.

on the east, through 140 degrees of longitude or a distance nearly half way around the world.

The flora has been found at very many localities in Europe associated with this fauna—in Portugal, France, Italy, Germany and throughout the Austrian empire. The less precise work, or possibly the absence of as good material because of the inadequate facilities for preservation in the river floodplain deposits of Asia has hitherto prevented the assembling of data regarding the Pliocene flora of the latter continent. In both Europe and Asia, however, this flora is found beyond the known limits of the fauna. A notable instance is that furnished by the plant remains found in the brick clays of the Holland-Prussian border and recently monographed by Clement Reid¹ and Laurent.²

This remarkable flora contains upwards of 300 species and shows a striking similarity to the living flora of the uplands of western China and to its more or less allied geographical provinces, *i. e.*, Japan, the Himalayas, eastern Tibet and the Malay Peninsula. A more remote relationship is shown with the existing flora of Europe or the Caucasus, and a still more remote relationship with the existing flora of North America.

This oriental character, using that term in the sense of its application to existing floral distribution, is shown by the presence in Limburg during the late Pliocene of forms like *Gnetum scandens*, *Zelkova keaki*, *Pyrularia edulis*, *Magnolia kobus*, *Prunus maximoviczii*, *Stewartia pseudo-camellia*, etc., no longer natives of Europe, as well as by representatives of genera such as *Meliosma*, *Actinidia*, *Corylopsis*, *Camptotheca*, etc., not found in the existing European flora but represented by closely allied species in China. Even when the genus is still a member of the European flora, the fossil species appears to be closer to the existing Asiatic rather than the existing European representative, as, for example, in the genera *Pterocarya*, *Styrax*, *Betula*, *Cornus*, *Clematis*, *Eupatorium*, etc. There are among the fossils, however, a number of large-seeded forms that are still represented in the flora of Europe, among which may be mentioned *Picea excelsa*, *Quercus robur*, *Carpinus betulus*, *Corylus avellana*, *Prunus speciosa*, *Ilex aquifolium*, *Vitis vinifera* and *Fagus cf. silvatica*.

¹ Reid, C., and E. M., "Preliminary Note on the Fossil Plants from Reuver, Brunssum and Swalmen," *Tijdsch. Kon. Ned. Aardrijks. Genootschap*, 2e ser., Deel XXVIII., afl. 4, 1911, pp. 645-647; "The Pliocene Floras of the Dutch-Prussian Border," *Mededeelingen Rijksopsporing van Delfstoffen*, No. 6, The Hague, 1915, 178 pp., 4 tf., 20 pls.

² In Jongmans, W., "Rapport over zijne paleobot," *Rijksopsporing van Delfstoffen*, Jahren 1908-11, pp. 23-25; Laurent, L., "Note preliminaire au sujet des plantes pliocenes des argiles du gisement de Reuver et des gisements voisins," *Ibidem*, Jahren 1914, 4 pp., 1915.

The Reuverian flora, as it has been called, appears to indicate a climate about like that of southern France of the present time, but with a more abundant rainfall. It was richer in species than the present flora of central Europe and the number of arborescent forms was greater, both relatively and absolutely, comprising fifty per cent. of the determined forms. A somewhat similar Pliocene flora was described some years ago from the Altai Mountains³ in Central Asia. In the latter region were found sequoias, alders, oaks, beeches and tulip trees of North American character associated with oriental beeches, walnuts and maples, as well as with various other trees now characteristic of Mediterranean Europe.

These late Pliocene floras are frequently spoken of as cosmopolitan floras and in the sense that throughout the whole Holarctic region there was not then the geographical differentiation that is displayed by the existing floras this term is true. It does not mean that the semi-arid plains of Algiers had identical species with the forested glades of southern France or that the tropical forests of Indo-China were identical with those of the Asiatic steppes, but there were no well-marked provinces—in Portugal, France, Italy and the Altai we recognize the familiar types like the Sassafras, Magnolia and Tulip tree, which to-day are confined to southeastern Asia or southeastern North America.

This in brief was the setting in which were inaugurated those climatic changes so striking in their results, but probably not nearly so extreme in their actual changes, that resulted in covering so much of Europe and North America with a continental ice sheet many feet in thickness. This was also the setting of that event, great from our human standpoint, when somewhere in the orient the ape-like ancestors of man passed the intangible bound that separated apedom from incipient manhood, for in the older Pleistocene of the island of Java we find the oldest known fossil remains of such an ape man, the *Pithecanthropus erectus* of Dubois, associated with the bones of a large contemporary fauna; and the foliage, fruits and wood of the valley forest in which these remote ancestors of ours dwelt.

The exact age of the strata containing the remains of *Pithecanthropus* is of the greatest importance and on this point as well as on the questions of the environment and climate the fossil flora is much more definite and conclusive than the associated vertebrate and invertebrate fossils. Let us then endeavor to picture the surroundings of the ape man and the animals and plants that spread with him into Java from the river valleys of the Brahmaputra and Irawadi, two thousand miles or more to the northwest, and something of the geography and topography of the lands through which they wandered.

The Pleistocene was in general a time of receding oceans and broadland connections. Some think that this fall in sea-level was due to the

³ Schmalhausen, J., "Palæont.," Bd. 33, 1887, pp. 181-216, pl. 18-22.

great amount of water that went into the formation of the ice sheets; at any rate, we know that all the continents were connected, a wide land bridge extended from Asia to North America across Bering sea. In the southeastern Asiatic region the shallow southern half of the China sea, the Gulf of Siam and the shallow Javan sea were all dry land—vast, fertile and well-watered plains teeming with life. Sumatra and Java were connected with Borneo and the Malay peninsula and formed a part of a broad eastward extension of land that reached to and included Timor, the present eastern outpost of the spice islands. These seas are still so shallow that ships can anchor in any part of them.

The Menam River was lengthened a thousand miles and flowed through the Gulf of Siam and sweeping around to the northeast discharged into the China sea. A great Javan river with its headwaters in the vicinity of the straits of Malacca flowed eastward and southward, receiving many large and small tributaries from the uplands of Borneo and Sumatra. It flowed in a broad and densely forested valley extending for a thousand miles along the bed of the Java sea and emptied into the Flores Gulf. The mountain axis of Borneo continued northward nearly or quite connected with Luzon by the enlarged Palawan and Mindoro islands. The Sulu archipelago was a part of western Mindanao and nearly or quite reached north Borneo. The Sangir islands were connected with the northern arm of the Celebes and nearly or quite reached Mindanao while a narrow strait separated Celebes from Borneo, widening north of the former to form the Pleistocene Celebes sea. The Andaman and Nicobar island festoon was connected with lower Burmah forming the large and almost land-locked Gulf of Burmah. The mountain axis of Sumatra was continuous across Java and on to the eastward, for the fault which formed the narrow Sunda Strait between the two islands was not yet in existence. The Pleistocene was also a time of great volcanic activity in this whole region. Java has about 125 volcanic centers many of which are great peaks, but only 13 of these are feebly active at the present time. During the Pleistocene volcanic activity was at a maximum, as is shown by the fact that not only 28 per cent. of the present area of Java consists of these rocks, but most of the remaining area is made up of sediments that are largely volcanic débris. I have endeavored to picture the probable geography of the early Pleistocene in the southeastern Asiatic region in the accompanying sketch map (Fig. 2).

During the early Pleistocene broad and fertile river valleys extended from the Punjab eastward and southward. From the sharp turn in the Brahmaputra at Sadiya in Assam great valleys or verdant coastal plains flanked by salubrious uplands extended southeastward for a distance of between two and three thousand miles and it was along these coastal plains and valleys and the parallel mountain ridges that upland and

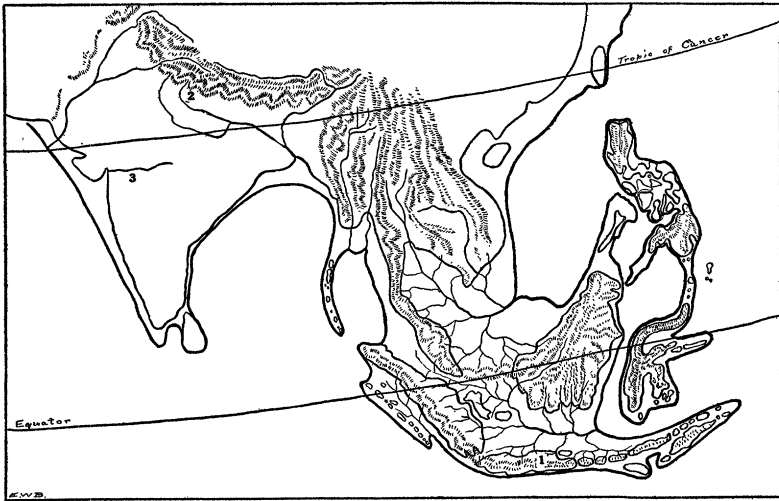


FIG. 2. SKETCH MAP SHOWING PROBABLE LAND CONNECTIONS IN THE SOUTH-EASTERN ASIATIC REGION IN THE EARLY PLEISTOCENE. 1, Location of Trinil fossil faunas and floras. 2, Location of Pliocene Siwalik faunas. 3, Location of Pleistocene Narbada faunas.

lowland animals and plants were able to spread simultaneously toward the southeast. The relative elevation of the Himalayan region and a slight lowering of temperature combined with the pressure of population were sufficient to cause this organic flood to gradually spread to the southward.

The *Pithecanthropus* or Trinil men as pictured to us by the anthropologists were of low intelligence, as is indicated by the slight development of the frontal region of the brain, by their cranial capacity of from 850 to 900 cubic centimeters as compared with 600 cubic centimeters for the largest simian brain and 1,200 cubic centimeters for the Neanderthal men of the Third Interglacial period. From a study of the inside of the cranium of the Trinil man it is estimated that the lower frontal lobe, the speech center, was twice as well developed as in any existing anthropoid ape, but still only about half that of Modern man, so it seems certain that the Trinil race possessed at least a rudimentary power of speech.

The remains of the fauna that was contemporaneous with the ape man include fifteen species of land and fresh-water snails and river clams, all of which are still living and in the same general region at the present time. There are several genera of fresh-water fishes; a gavial very close to the existing armored crocodile of the Ganges and a true crocodile close to the existing crocodile of Java and Borneo. Five river and swamp turtles have been described, all similar to living types of farther India and the Sunda islands. Among the birds were parrots

and marabouts. Over a score of mammals, a typical forest and stream border assemblage, have been described. These comprise a macaque, several carnivores including both dogs and cats, two rhinoceroses, a hippopotamus, two wild hogs, several deer including the Sambar deer of India and the Kidang deer still living in Java, buffalo and wild cattle, the porcupine, a large pangolin and hyena, a tapir like the existing Sumatra tapir, and at least three elephants—a *Stegodon* and an *Elephas*, both close to Indian species of the Pliocene (Siwalik) and Pleistocene (Narbada), and another *Elephas* like the straight-tusked *Elephas antiquus* of the early European Pleistocene. This fauna as well as the associated flora are conclusively continental instead of insular in character and were clearly derived from the northwest.⁴

Dubois discovered the remains of *Pithecanthropus* in 1891 along the Bengawan or Solo River near the little hamlet of Trinil in east central Java. To the north are the low east and west range of the Kendeng Hills, to the south lies the high cone of the volcano of Lawoe. His discovery excited the greatest interest and a vast literature has centered around the ape man long thought to be Pliocene in age. During 1907 and 1908 the Selenka expedition made careful excavations at Trinil with the object of supplementing Dubois's scanty material, collecting many vertebrate remains and also the fossil plants which throw such a welcome light on the exact age and environment of the ape man, but failed to find any additional *Pithecanthropus* remains. The deposits are fluvatile with little regularity in the sequence of bedding and consist of alternating lenticular beds of volcanic débris (lapilli and ashes) sometimes clayey and sometimes sandy, with a total thickness of about 50 feet. The general sequence is as follows:

Recent alluvium.

Kendeng beds	{	Red ashes and lapilli.
		Argillaceous tuff.
		Tufaceous sandstone with a few leaves and bones.
		Tufaceous sandstone with clay balls containing shells.
		Interbedded ash and clay (main plant layer), a few bones.
		Tufaceous sandstone (main bone layer) (<i>Pithecanthropus</i>), a few plants and fresh water-shells.
		Lahar conglomerate.

The restricted size of the present island of Java, probably of post-glacial origin, proved inimical to some of the larger mammals, for the elephant and tapir are absent in the existing fauna, although a rhinoceros still inhabits the uplands. The recentness of Java's separation from the mainland is shown by the Siamese and Indian character of its

⁴ Vertebrate paleontologists differ regarding the distinctness of the majority of these animals from those still existing. The majority of the fossils are certainly very close to modern oriental forms.

present fauna and flora. Of its 90 existing mammals no genera and only 5 or 6 species are peculiar. Of its 300 land birds many are Indo-Chinese and only about 45 are peculiar. The modern flora is also distinctly Malayan or Asiatic in character.

The plants found associated with the ape man are of the greatest interest. They number 54 species and the remarkable fact should be noted that none of these are extinct species, a sure indication of their Pleistocene age. Twenty-two families are represented, the most abundant being the bread fruit banyan or fig family (Moraceæ), the custard apple or pawpaw family (Anonaceæ) and the laurel family (Lauraceæ). There were banyans and figs, jack fruit, mangosteen and custard apple, senna and beans, and a variety of other fruit-bearing trees that may have yielded toll to the Trinil race. The Chinese banyan, a large widely spreading, fast-growing tree, a twig of which is shown in the accompanying sketch (Fig. 3), was present at Trinil at that time. The rasamala

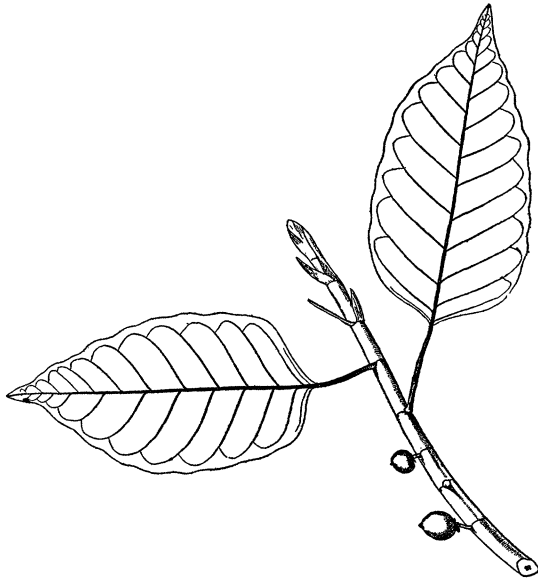


FIG. 3. LEAFY FRUIT BEARING SHOOT OF THE CHINESE BANYAN, *Ficus infectoria* Roxb., found fossil at Trinil. 3/7 nat. size.

(*Altingia excelsa* Noronha) related to our sweet gum was also found at Trinil. To-day it does not occur in the vicinity, although it is one of the tallest and noblest trees of central and western Java, extending thence northwestward to the Asiatic mainland.

The present geographical distribution of these early Pleistocene plants is somewhat different from what it was at the time of the ape man and these differences are a measure of the time that has elapsed since those remote days. Only ten of these plants still flourish in the im-

mediate vicinity of Trinil, where the climate is now drier and somewhat warmer, but 32 of them, or 62 per cent., are still found in Java. Twenty-nine, or 57 per cent., are mainly Indo-Chinese and one (*Uvaria*) is now confined to India and Ceylon. The flora was an evergreen forest flora, upland in character, and is much like that found at the present time in the Khassis Mountains of Assam. It indicates the very heavy rainfall of about 150 inches yearly as compared with 60 to 100 inches of the modern records. A mean annual temperature of about 70° is indicated for the early Pleistocene as compared with 75° to 80° of the present.

The heavy rains and slight lowering of temperatures appear to correspond to the times of glaciation in Europe and North America, for it is well known that glaciation in high latitudes was contemporaneous with pluvial periods in the tropics. The survival of so many mammals like those of the Pliocene of the foothills of the Himalayas indicate that the Trinil man lived in early Pleistocene times, but the fact that none of the numerous associated fossil plants are extinct species and that none are identical with known Pliocene plants from Java and Japan indicate that it must have fallen well within the Pleistocene. That the lower bone bed was not appreciably older than the main plant bed which lies over it is shown by the presence of some of the same species of plants and fresh-water shells in the bone bed and by the presence of some of the bones above the main plant bed. We are thus led to the conclusion that *Pithecanthropus* lived in the tropical evergreen forests of Java during the first or second periods of glaciation in Europe and North America, or during what Europeans call the Scanian (Günz) and Saxonian (Mindel) glaciations, corresponding to our Nebraskan and Kansan ice sheets.

This was a long time ago, just how long it is difficult to say. Penck from very careful estimates based on a detailed study of the glaciers of the Alps estimated that the duration of the Pleistocene was between 520,000 and 840,000 years. Osborn considers that *Pithecanthropus* lived about 500,000 years ago. Personally I believe these estimates to be too large. One fact stands out clearly, that very many thousands of years have passed since the ape man and the elephants and hippopotami roamed over Java. Some realization of this time may be gathered if we deal in the more positive ratios rather than in actual estimates of years. If the time that has elapsed since the margin of the ice sheet blocked our great lakes and covered New England be taken as a unit, then the lapse of time since *Pithecanthropus* was buried in the river sands of Java was at least twenty times as great.

When we look at the admirable restoration of *Pithecanthropus* by McGregor we see many indications of the ape ancestry and yet he has managed to catch a look of fleeting intelligence and a dumb prophetic gaze that gives a promise of the great things that the descendants of

this far-off ape man were to accomplish. Whether this early Pleistocene man, by far the oldest yet known, stood in the direct line of ascent to the Neanderthal man which we find later on in Europe, or whether he represented an offshoot of this line, yet one can not contemplate his few bones that have come down to us or that empty brain case without a tremendous thrill.

The earth had been luxuriant and mild for eons, practically all the modern types of animals and plants had already been evolved and then in the dawning days of the Pleistocene with the coming on of more severe climatic conditions we find the early representatives of our own race, subsequently evolving into nomadic hunters and artistic cave dwellers, that spread all over southern Europe, migrating westward in successive waves from the more arid orient. Races that saw the great glaciers of the Rhone and the Rhine and hunted the wild horses and mastodons in southern France. It is a most inspiring history beside which Nineveh and Tyre are as but yesterday.